organic remains contained in these strata, *without being at the time aware that I had twelve years previously announced the same conclusions for all magnesian limestones, and established them on chemical grounds.*" The italics are ours, for Prof. Ramsay's especial benefit. The author concludes his last essay on the theory of types in chemistry, with some good advice to a thoughtless-Sterry-Hunt-neglecting posterity :—"In conclusion I have only to ask that future historians will do justice to the memory of Auguste Laurant, and will, moreover, ascribe to whom is due the credit of having given to the science, a theory which has exercised such an important influence in modern chemical speculation and research; remembering that my own publications on the subject, which cover the whole ground, were some years earlier than those of Williamson, Gerhardt, Würtz, or Holbe." It is a pity that much good scientific work should be encumbered by these vanities, and really much that is objectionable can be compensated by the study of such essays as those on the chemistry of natural waters, which is admirable and suggestive.

THE PHILOSOPHY OF MUSIC

The Philosophy of Music. Royal Institution Lectures. By W. Pole, F.R.S., F.R.S.E., Mus. Doc. Oxon. (London : Trübner and Co., 1879.)

IT has long been felt by intelligent persons anxious to possess some acquaintance with the scientific side of music, that the technical works to which they have recourse for the desired knowledge are unsatisfactory from a logical point of view. We are acquainted with no work on technical music which offers any reasonably intelligent explanation of the basis on which its material is founded; and a school has arisen, no doubt partly as a reaction from the crude speculations and unsupported dogmatism of many standard works, which refuses to acknowledge anything beyond the mere acquirement of technical facility in composition as a desirable object in the study of the so-called science of music.

The work of Dr. Pole appears to be intended as a protest against this limitation. It is an endeavour to make plain so much of æsthetic and physical acoustics, and the *rationale* of technical music, as may enable the musician to give some sort of intelligent reason for the faith that is in him.

Dr. Pole's well-known musical attainments are a guarantee for the soundness of the work so far as musical technicalities are concerned. As to general questions of evolution, the nature and objects of musical grammar, the origin and nature of scales, and of the technical rules of music, we think that this book leads the way among English works, in a logical, or perhaps we had rather say, in a common sense treatment of the subject.

It is useless within the limits of this article to attempt to convey any idea of the arguments employed. For the most part the opinions of Helmholtz have been adopted. Whatever may be the ultimate opinion as to the absolute accuracy of these views, there can be no doubt that their admission changes the fundamental study of music from an unmeaning dogmatism into a science.

The first part of the work gives a sketch of the material of music, and forms a treatise on elementary acoustics. The second part deals with the evolution of melody, the history of the scale, melodic and harmonic relations, rhythm and form. The third part is entitled "The Structure of Music." Its most important items are the history of harmony, and the discussion of its rules, combinations, and progressions. It concludes with a slight notice of counterpoint. The characteristic of the book seems to be that a good idea may be obtained from it of a sound body of musical doctrine, comprising foundation, history, and technique.

We select two or three points for notice, as to all of which we are not perhaps quite in accord with Dr. Pole.

There is something yet to be said as to the difference in the way in which the highly gifted musician and the ordinary listener hear music. The observations on the decay of counterpoint (p. 288) seem to want some notice of this. It is more or less a waste of energy to write music in many parts, all of which are made melodious at some sacrifice of the harmonic effect, when not more than perhaps one in a hundred listeners is capable of hearing more than one melody at a time. We think that it is not the power of writing counterpoint that has died out so much as the will to write it. There can be no doubt that the unpopularity of counterpoint is mainly due to the fact that the ordinary listener is unable to hear in it what the highly gifted musician hears. The many simultaneous melodies are quite lost on the ordinary listener. It is only in the case of the greatest composers, whose principal melodies and harmonies do not suffer by their attention to the counterpoint, that works of this class attain any popularity. Until the acquirement of the power of hearing many simultaneous melodies is placed within the reach of the ordinary listener by a suitable and widespread education specially directed to this purpose, it is useless to look for a popular interest in counterpoint, which shall encourage the composer to produce it. There is a question how far it is possible for a person not naturally gifted with the polyphonic ear to acquire it in perfection. But there can be no doubt that systems of education are possible which will do much towards advance in this direction; and that the direct cultivation of polyphonic hearing and reading is the shortest cut towards the formation of the true musician.

There is an incompleteness in Dr. Pole's statement of Helmholtz's explanation of consonance and dissonance, which is important, as it affects the logical foundation of this part of the work, which however forms but a subsidiary portion of Dr. Pole's book. The point in question has been discussed at large some time ago by Prof. Mayer, Mr. Sedley Taylor, and others. It will be sufficiently explained by quoting the summary of the principles which Dr. Pole employs in the discussion of the examples of chords, and also a passage from Helmholtz which contains the considerations omitted.

(Dr. Pole's book, p. 210.) "Now having given these two data, velocity of beating, and strength of beating notes, we may examine some of the binary harmonic combinations of sounds, and see in what manner and to what extent the partial tones, of which the sounds are made up, give rise to the beating or harshness above described."

The following passage will show that another set of data is required, namely, the law according to which the

production of beats in the ear between pure tones depends on the interval:—

(Ellis's "Helmholtz," p. 260.) "On the other hand we have seen that distinctness of beating and the roughness of the combined sounds do not depend solely on the number of beats. For if we could disregard their magnitudes all the following intervals, which by calculation should have 33 beats, would be equally rough:—

"The semitone	b' c''
,, whole tones	c' d' and d' e'
,, minor third	e g
,, major third	c e
,, fourth	G c
,, fifth	C G
(to which we may add the octave	C_1 C).

"and yet we find that the deeper intervals are more and more free from roughness."

Helmholtz then proceeds to give an approximate determination of this important law, for which we must refer to his work. Our own impression is that this law is almost solely concerned in the variation of the roughness of different combinations. We ourselves hear the roughness of beats up to very high numbers, and consider that up to high numbers beats of sensible intensity do not fail to be heard by reason of their number only. If this is the case the rapidity of beats must be of less importance in the theory of consonance than the law of dependance on intervals exhibited in the above quotation from Helmholtz.

To show the practical importance of this:—

(Pole, p. 213.) "Here we find the two fundamental notes themselves (c' – e') beating at the rate of 64 per second. . . . This is, therefore, a less perfect combination than the fifth; but still the beats are quick, and the effect is not disagreeable."

This seems to us incorrect. If the 64 fundamental beats per second were present with any intensity to speak of, the combination would certainly be most dissonant. It is because the ear receives the two notes on different parts of the sensorium, and so gets them out of each other's way, that the beats do not exist in sensible intensity, and do not produce dissonance.

In the appendix on Beats, and an essay there referred to, Dr. Pole has developed doctrines which arise to some extent from the point of view above indicated. The statement made is substantially that the beats described by Robert Smith ("Harmonics," 1749), have a real existence, besides the various types of beats described by Helmholtz.

Smith's cycles are best seen if the sum of two harmonic curves be described by Donkins's harmonograph, or some such machine. Smith's doctrine consists of the statement that the cycles which appear in the resulting curves are the cause of the beats. (Of course Smith did not use pendulum-vibrations, but the use of these adapts the doctrine to our modern knowledge.)

Now in order that these cycles may be seen, it is necessary that one and the same scribing point should describe the sum of the two motions simultaneously. If the motion be analysed and its two components be described separately on the paper, the cycles fail to appear.

This is what must happen in the ear if the doctrines of Helmholtz are even approximately true. The two sounds (if beyond the minor third apart) fall more or less completely on different parts of the sensorium, and the conditions requisite in the first instance for the formation of Smith's cycles are not fulfilled. Whether, if the cycles existed, the beats could arise out of them in the way in which we hear them, is quite a different question, on which we will not now enter.

The great importance of this question has induced us to prolong our remarks on it. On these points every student should consult Helmholtz's work. But on the more purely musical questions Dr. Pole's book has its own value.

OUR BOOK SHELF

A Treatise on Chemistry. By H. E. Roscoe, F.R.S., and C. Schorlemmer, F.R.S., Professors of Chemistry in Owens College, Manchester. Volume II. Metals. Part II. (London: Macmillan and Co., 1879.)

THIS portion of Professors Roscoe and Schorlemmer's work treats of the metals of the iron, chromium, tin, antimony, and gold groups, also of spectrum analysis, the natural arrangement of the elementary bodies, and the condensation of the gases formerly called permanent. The treatment of these subjects is characterised by the same accuracy of description and clearness of explanation and arrangement that were so conspicuously displayed in the former parts, and the illustrations of metallurgical operations, &c., are well chosen and admirably executed, such, indeed, as are not to be found in any other English manual of chemistry. Amongst them may be especially noticed the figures of the plant for Weldon's method of regenerating manganese dioxide from chlorine residues, of the various forms of blast-furnace, of the Bessemer and Siemens-Martin processes for making steel, and of hydraulic gold-mining as practised in California. The best methods of detecting and estimating the several metals are carefully described, and interesting details are given relating to their history, some of which will, we think, be new to many readers.

Spectrum analysis, in which Prof. Roscoe is known to be a high authority, is well treated and illustrated, and attention is drawn to recent speculations, founded on spectroscopic observation, respecting the possible resolution of the bodies now regarded as elementary, into still simpler forms of matter. In the chapter on the Natural Arrangement of the Elements, a clear view is given of the remarkable relations between the properties of the elements and their atomic weights, first pointed out by Mr. Newlands, and further developed by Lothar-Meyer, and Mendelejeff; and the volume concludes with an account of the condensation of the gases formerly regarded as permanent, in which the ingenious forms of apparatus employed for the purpose by MM. Cailletet and Pictet are fully described and illustrated.

Altogether the two volumes of the work now published form a treatise on Inorganic Chemistry of which English science may well be proud; and the student who masters their contents will not fail to acquire a sound elementary knowledge of the subject. H. WATTS

Elementary Mechanics, including Hydrostatics and Pneumatics. By O. J. Lodge, D.Sc. Chambers's Elementary Science Manuals. (Edinburgh, 1879.)

THIS is one of the comparatively sound text-books which, since the publication of Thomson and Tait's work, have been every year more effectually thrusting aside the cumbrously artificial and often erroneous introductions to Physical Science which reigned almost unchallenged till about sixteen years ago. Dr. Lodge knows his subject well, and has evidently bestowed very careful thought upon it. Still we cannot unreservedly commend his book; and this for several reasons. First, he evidently proceeds under the idea that the subject can be made